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SPECIFICATION

TITLE

"VENTILATOR"

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a ventilator of the type having an inspiratory unit and an expiratory valve for regulating a flow of breathing gas, and a control unit for controlling the inspiratory unit and the expiratory valve.

Description of the Prior Art

Mechanical ventilation is employed to control or support a patient's breathing. Breathing gas at a positive pressure is supplied to the patient. In many instances, ventilation is a vital necessity for the patient, however, the treatment in itself is not without risks. Numerous studies of animals suggest that ventilation can initiate or aggravate lung damage. A major contributory reason for this is the mechanical stress to which the pulmonary system may be subjected during ventilation. In particular, damage can develop or be aggravated when alveoli in the lungs cyclically open and collapse during inspiration and expiration.

Moreover, some patients suffer from such severe conditions that using a treatment that can cause some damage to the lungs is the only way to save the patient's life.

One way to prevent alveolar collapse is to impose a positive pressure on the lungs, even during expiration, with a positive end-expiratory pressure (PEEP). However, PEEP cannot be set too high, since a high PEEP can subject the lungs to harmfully high pressure during inspiration. An excessive inspiratory pressure can impede blood perfusion in the lungs (causing poorer oxygenation of the blood) and even inflicting damage to pulmonary tissue.

Recruitment phases can be employed instead of a constantly high PEEP. During a recruitment phase, the pulmonary alveoli are opened with a pressure (usually higher than the normal inspiratory pressure for the patient), enabling them to remain open when exposed to a lower pressure during a subsequent period of treatment. The recruitment phase is repeated as needed.

A number of procedures are known for instituting the recruitment phase. One is often referred to as the 40/40 method. This means that the lung is subjected to a pressure of about 40 cmH_2O for up to 40 seconds.

This is a static procedure and rather hard on the lung and the patient, but it is a simple maneuver producing clear results in the form of improved oxygenation of the blood.

Another procedure involves the use of a number of brief pressure pulses, e.g. three, each lasting 15 seconds.

In principle, the effect is the same as in the aforementioned instance. However, static methods have a major shortcoming in the buildup of carbon dioxide in the lungs during the recruitment phase.

A third known procedure involves a successive increase in pressure in the lungs during, in principle, normal breaths until a satisfactory degree of opening is achieved.

This is without doubt the easiest method on the lung and patient, but it is highly demanding and difficult for staff to implement.

SUMMARY OF THE INVENTION

An object of the invention is to provide a ventilator with which at least some of the aforementioned problems can partially be avoided.

The above object is achieved in accordance with the principles of the present invention in a ventilator having an inspiratory unit and an expiratory valve for regulating a flow of breathing gas, and a control unit for controlling the inspiratory unit and the expiratory valve, wherein the control unit controls the inspiratory unit and the expiratory valve to generate a recruitment phase with an elevated basic pressure for the breathing gas, upon which a number of breaths is superimposed at a faster breathing rate.

A number of advantages are achieved with a recruitment phase consisting of a static increase in pressure combined with a superimposed series of breaths at a faster rate.

Carrying out the maneuver then becomes relatively simple whenever necessary. The maneuver is also effective, since the static pressure, combined with the superimposed breaths, leads to more effective opening of the alveoli and improved scavenging of carbon dioxide.

The magnitude of the elevated basic pressure depends on the patient and the illness, but the pressure is usually in the 10-80 cmH_2O range for most patients. Preferably, a range of 30-60 cmH_2O is used.

The superimposed breaths can be pressure-regulated and then have a pressure amplitude ranging from 1-10 cmH_2O.

Alternatively, the superimposed breaths can be volume-controlled and then have a tidal volume ranging from 1-100 ml.

The increased respiratory rate can suitably range from 50-200 breaths/minute.

The increased respiratory rate can also be viewed as a percentage of a set respiratory rate, for instance between 110% and 1000% of the rate (i.e. 10% to 100% higher than the rate). Higher percentages can be possible, depending on the set rate, the ventilators capacity of supplying high rates, etc.

The recruitment phase can suitably last from 10-100 seconds. With the ventilator according to the invention, the recruitment phase can be sustained for a longer period than in the prior art, since the superimposed breaths do cause some gas exchange.

DESCRIPTION OF THE DRAWINGS

FIG. 1 shows one embodiment of a ventilator according to the invention.

FIG. 2 shows a first example of a recruitment phase according to the invention.

FIG. 3 shows a second example of a recruitment phase according to the invention.

DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a ventilator 2 according to the invention. The ventilator 2 is connectable to a patient 4 in order to supply and evacuate breathing gases.

Breathing gas is delivered to the ventilator 2 through a first connector 6A and a second connector 6B, and an inspiratory unit 8 mixes the gases in the right proportion and with the right pressure and flow.

The breathing gas is then carried to the patient 4 in an inspiratory line 10 and from the patient 4 back to the ventilator 2 in an expiratory line 12.

An expiratory valve 14 then regulates the outflow of breathing gas from the ventilator 2.

The inspiratory unit 8 and expiratory valve 14 are controlled by a control unit 16 in order to generate the pressure and flows to which the patient 4 is to be subjected.

Supplying the patient 4 with e.g. recruitment phases is possible. One example of such a phase is shown in FIG. 2. The recruitment phase is shown with a curve 18 in a pressure-time (P-t) diagram. In the recruitment phase, pressure from the basic pressure (PEEP), which can range from 0 to a positive pressure of 10-15 cmH_2O (or higher if the situation calls for it), is raised to

an elevated basic pressure Pr. The elevated pressure Pr can be up to 80 cmH_2O. Breaths 20 are then superimposed on this basic pressure Pr. The breaths 20 are pressure-regulated and have a pressure amplitude ΔP from 1 to 10 cmH_2O. The superimposed breaths 20 are also imposed at a faster rate, i.e. from 50 to 200 breaths/minute.

The recruitment phase 18 has a duration tr lasting 10 to 100 seconds.

The objective of the recruitment phase is to open regions of the lung containing collapsed alveoli.

FIG. 3 shows an alternative version of the recruitment phase. It depicts a volume-time (V-t) curve 22. As in the preceding example, an elevated basic pressure is imposed. In normal instances, this would generate an effect similar to the curve 24, but the curve 22 is instead achieved because of superimposed volume-controlled breaths. These breaths have a tidal volume of 1 to 100 ml.

As the FIG. 3 shows, the curve 22 ends with a larger total volume than the curve 24 at the end of the recruitment phase. This is because the superimposed breaths assist in opening more alveoli.

Although modifications and changes may be suggested by those skilled in the art, it is the intention of the inventor to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of his contributions to the art.